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TITLE: Video system for producing video images simulating images derived from motion picture film

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Abstract Paragraph Left (1):
Digital signals are generated and stored for each pixel of a frame of high definition video originated material. A computer reads the digital signals and converts them to binary image data by employing a selected look-up-table program to reassign color and black component values for each pixel. The programs applied in the component value reassignments are compiled from, and based on, comparative digital video component results of telecined film stocks' responses to selected color and grey scale gradients as charted against a selected video unit's response to the same charts under a selected number of identical lighting circumstances. The revised digital data is assembled and converted to an analog signal for a secondary modification wherein: A projector unit projects the high definition video frame through a macro lens onto a strip of exposed and processed motion picture film of an optional grey scale gradient and thus grain pattern density. An automatically variable filter over the projector lens compensates to maintain the same brightness result from the opposite side of the film surface. A precisely aligned, compatible high definition camera unit provides a synching signal to the projector and automatically frames and focuses on the projected image from the reverse side of the celluloid surface, scanning the projected scan lines, to output the grain-embodying image for recording and displaying on a high definition format or external conversation to NTSC for broadcast purposes.

Brief Summary Paragraph Right (1):
The system of the present invention seeks to arrive at an aesthetically acceptable simulation of the appearance images originated on different motion picture film stocks embody after telecine "flying spot scanner" transfer to video, from taped high definition video originated images. And, to provide new options in processing video originated material, not limited to approximating the results images originated on a film stock would have manifested on video of a given videographic subject.

Brief Summary Paragraph Right (2):
This invention relates to the simulation of video images originated on motion picture film stocks, from high definition video originated material stored on tape.

Brief Summary Paragraph Right (3):
Film has been the preferred recording medium on which to originate many productions broadcast on television for years because of the sophisticated visual impression provided by the character of film stocks' color response and the general audience familiarity with the appearance resulting from filmed material presented on television; the resulting "look", a product of the photo-chemical process preceding the production of television signals representative of the image stored in the photo-chemical process, differs in several ways from video originated material of an identical photographic subject. Two key ways in which they differ are the focus of this invention: The color and grey scale component value response in each pixel of the resulting image on a television monitor; and the subtle visual impression made by the textured appearance of film grain, which is inherent to images stored within motion picture film emulsion.

Brief Summary Paragraph Right (4):
Though color negative film has the ability to reproduce abundantly more color and grey scale gradients than video originated images, when video images are created from filmed images by means of a standard telecine "flying spot scanner" transfer, an illusion of the entire range of film's color response is maintained. This phenomenon, occurring within the scope of the video medium, provides that constants exist that can define the variation in pixel response between film and video originated images shot under identical lighting conditions, when viewed on video monitors: It is the combination of filmed information as it can be reproduced on a monitor that provides the overall maintenance of the "film look", and each separate color component combination of each pixel of film originated image is in fact available and employed by video originated images, though in response to a different photographic stimulus in almost every case.

Brief Summary Paragraph Right (5):
The video data resulting from a telecine transfer defines filmed images in video terms, so the medium in question is in fact video, and the parameters and actual subtleness of projected filmed images are not the issue. Rather, the video data assigned to a resulting pixel representing a zone of film emulsion is an averaging process provided by video standards and color and grey scale gradients recognized as those registered and visible on standard television receivers.

Brief Summary Paragraph Right (6):
Digital video technology has provided that digital data defines video images and encodes the color and grey component values for each pixel in addressable sequences, able to be "read" and "rewritten" into a store. Therefore, given uniform and predominantly shadow-free lighting and even color temperature during original videotaping, and careful slating of this data for each shot in foot candles and degrees kelvin respectively, digital data logged from pixel response of color data originally stored in film stock emulsion, under the same light intensity and color temperature conditions, can be referenced according to principal videographic variables and inserted in place of the original video color data. This would create an aesthetic comprise that permits approximation of potentially any film stock's anticipated response to the same stimulus represented in video form.

Brief Summary Paragraph Right (8):
New high definition television systems and video projection systems capable of manifesting a high definition compatible number of scanning lines provide the means for executing a process whereby actual film grain within celluloid emulsion can be married with a projected image, and videographed with a loss in image clarity low enough to produce a final result which provides a film "look" to images at an aesthetically acceptable sacrifice to the original high definition integrity of the video images. Present systems strive to simulate film grain appearances digitally, with a result that is visibly different from actual film grain appearances on monitors, following a telecine "transfer." By incorporating the general videography-of-film operating basis of telecine devices, high definition projection and camera units mounted on tracks, with macro lensing, "gen-lock" synched together, matching scan lines to the highest degree possible can capture a complete video frame as it is projected on a grey emulsion surface of optional size. This recreation of a video signal of a high number of scanning lines from a high definition projection would have a resulting actual clarity substantially less than that of the original video material, but with the aesthetic look of film originated images. Present systems for providing an NTSC signal from a high definition signal may be employed at this stage, or the signal may be maintained as as higher definition signal for recording, monitoring or broadcasting.

Brief Summary Paragraph Right (9):
So, for many television applications where film is shot for telecine transfer to video, there are benefits to be gained by employing the system of the present invention. At the production level: a television camera is employed instead of a film camera providing silence; immediate screening of the actual material shot; immediate sound synching; lesser risk of reshoots from screening original material for problems immediately; and no expense of negative film. In post production: processing of film, transfer to video and sound synching are not needed; having shot video, dailies need not be awaited; all shot selections destined for final

modification by the "FILMITATOR" system are made in preliminary "off-line" edit sessions, minimizing the actual amount of material submitted for modification and thus time charges as opposed to a film shoot where typically all material must be transferred to tape, at substantial expense, for initial screening; and during modification by this system, a variety of film stock component response and film grain options may be previewed and imparted to the original video material, providing a unique range of new post-production aesthetic effects to video originated material.

Brief Summary Paragraph Right (10):
The system according to the present invention provides means for digitally modifying high definition video originated images shot under even, controlled lighting conditions, according to look-up table programs based on film-originated digital color and black component binary response logs. And, secondary means for imparting a variety of possible film-grain "textured" appearances to the image resulting from the primary modification with an apparatus which videographs a videoprojection of the color modified, high definition video signal from off the emulsion layer of variably dark strips of motion picture film.

Brief Summary Paragraph Right (11):
Standard video response to each gradient of red, green, blue and black distinguishable by broadcast television is derived from analyses of digital response data to color chart gradients, by a predictably responsive high definition video camera model, designated as a component of this system. The film originated digital "responses" are derived from cinematography of the same color charts under the same lighting conditions, with the conversion to digital video provided by a precisely adjusted telecine, "flying spot scanner" apparatus; binary data pertaining to single pixel component values are then logged accordingly. These digital results; the range of original video color data each digital "response" commands; and the number of charts assembled for a given film stock program, (designated and compiled according to combinations of original videography lighting conditions), define the amount of data held within each "look up chart" program and thus the color and grey-scale gradient reproduction detail available in a given film stock simulation program.

Brief Summary Paragraph Right (12):
In summary, the present invention provides a video signal modification system for converting video-originated images into final video images simulating images originated from motion picture film. To this end, conversion data located in look-up tables are used for reassigning color and black component values to the picture pixels in the video-originated images with the help of computing means to thereby produce intermediate video images. Grain pattern instilling means physically instill selected film grain patterns of optional density and size into the intermediate video images to thereby produce final video images which appear as though they were derived from motion picture film stock.

Drawing Description Paragraph Right (4):
FIG. 3 shows in detail, the variable density film grain-instilling apparatus from the left side; and

Drawing Description Paragraph Right (5):
FIG. 4 shows in detail, the celluloid containment assembly portion of the film grain-instilling apparatus, from the viewpoint of the camera unit of the film grain-instilling apparatus.

Drawing Description Paragraph Type 0 (10):
10--Film stock component simulation program

Drawing Description Paragraph Type 0 (13):
13--Film grain simulator/instiller apparatus

Detailed Description Paragraph Right (2):
In the post-production stage of this system, FIG. 1. diagrams the path of the video signal, while FIG. 2 diagrams the flow of system data which controls timing, positioning, synching and advancing of system components. In response to a frame-advance signal D1, the high definition playback deck 4, advances one frame,

and outputs this single frame of video data to analog-digital coverter 5. The binary data is held in frame store 6, and read from this store by system computer 7, at the rate dictated by the time required to modify data for each red, green, blue and black component for each pixel, scan-sequentially. To perform this digital modification, a single, selected look-up-table 10, is read by disc drive 9 and relayed as data D3 to the internal memory of the system computer 7, in accordance with a table select command entered through the system computer keyboard.

Detailed Description Paragraph Right (3):
The look-up-table selected is of the one-dimensional kind and is an element of a larger program which is representative of component responses of video material originated on a single film stock, in a variety of lighting circumstances. The digital representation of the film component responses are derived from telecine, flying-spot-scanner transfer to videotape: By filming color charts and grey scale charts containing at least those gradients deemed registrable by broadcast NTSC television and charting the binary component-data results against video originated images, shot with the selected high definition camera unit of this system of the same charts under the identical lighting conditions, a basis for translation is formed. A simple film stock program might contain tables for five f-stop settings, ten light intensity possibilities and five color temperature options; a total of 250 look-up-tables, contained on discs grouped according to f-stop setting, or depending on the volume of data within each table, an f-stop and a color temperature, with all lighting intensity options for the two fixed variables resulting in ten tables per disc, etc.

Detailed Description Paragraph Right (4):
Within a look-up-table, the component value translations may be as specific as to address the actual subtlety of film and the large number of color and grey scale gradients color negative film can register. But, because the process is designed for eventual display on a video monitor, the degree of specificity needed is immediately diminished by the inherent limitations of video. If data groupings of video data derived from videography of the charts are to be defined by those component gradients registrable by NTSC broadcast television, the range of original video component data in a single grouping is broadened further, and number of corresponding look-up-table "answers" are reduced in comparison to the huge number of groupings that might be logged. So, the degree of detail available within a single look-up-table, or the table's capacity, is determined by the intended display system and a determined level of modification deemed acceptable as a compromise between the size of the tables to be assembled and the aesthetic result of the component modifications; it is an option determined by the intricacy of a given program assembled for this system as implemented by a system computer internal memory capable of storing at least a single table of the greatest detail that might be needed for the most sensitive monitoring systems applicable. Each component's digital "word" is thus read, for each pixel, and replaced by the corresponding answer "word" which is referenced in the table and determined to govern the range of original videography data in which the "word" submitted falls. The binary response, indicating the approximate anticipated component value response had the program film stock been the original image storage medium, is output to a receiving frame-store 11, in which the revised frame of digital video data is assembled. This data is then converted to analog by digital-analog converter 12, and is relayed at normal scanning rate, for display, to apparatus 13 for a secondary modification.

Detailed Description Paragraph Right (5):
Apparatus 13, is designed to physically instill a variety of actual film-emusion grain apperances to images manifested from the primary digital modification process of this system. As detailed in FIG. 3, diagraming the film-grain instilling apparatus, high definition projection unit 21, is the component which receives the modified high definition analog video signal. This projection unit is preferably of the type capable of reproducing the level of definition and number of scan lines provided by the video signal. Facing the projection unit lens is a high definition camera unit 22, to which the projector is gen-locked, by means of a synching signal D8, output to the projector by the camera unit internal synch generator 39. The camera and projector are mounted on tracking 33, which by means of motor 34, allows them to simultaneously move toward or away from each other in response to a signal D4 output by the system computer, which commands the units to approach eachother a

short distance if 16 mm film grain is to be simulated, or to move away to simulate a 35 mm grain size. Variable focus, macro lenses 23 and 24, on both the projector unit and the camera unit also respond accordingly to system computer generated signal D5 by focusing for an image manifest area of either 16 mm or 35 mm in width automatically, as provided by focus-pulling motors 25 and 26.

Detailed Description Paragraph Right (6):
Between the camera and projector lenses is a length of celluloid 36, preferably comprised of reversal motion picture film stock, which is contained between two rollers 31, and kept taught between the containment rollers by torque motor 27. Being of at least a meter in length and at least 175 mm in width, (meaning top to bottom in FIG. 4), the portion of the celluoid length not visible between the containment rollers, is "spooled" on the rollers. Comprised from top to bottom of 35 mm strips of different grain density and thus darkness, the celluloid length is a continuous piece containing grey scale gradient strips created by actually exposing and processing the celluloid-film sheath for this use, accordingly.

Detailed Description Paragraph Right (11):
From the high definition master VTR 14, the image is relayed as a complete frame to compatible high definition monitor 15. From this balanced monitor display, all aesthetic system adjustments to a scene are made by previewing a single frame and those resulting changes different film stock programs, celluloid density strips for projection, or manual adjustments made through external color or signal modifiers would have on the original video image. In a more sophisticated system, cascade filtering circuit technology, (U.S. Pat. No. 4,885,787) may provide means to modify pixel data quickly enough to preview and view modifications of scenes in real time, so option settings need not be made according to the appearance of a single image and real-time modifications can be seen before they are insert recorded. A configuration of the system of the present invention may also provide for a system computer with an internal memory capable of recalling an entire film stock program, instead of just one look-up-table, the minimum amount of data necessary for modification of a complete video frame; this would save time during set-up for modification of each new scene having a different corresponding look-up-table within the same film stock program.

Detailed Description Paragraph Right (12):
Though the present system strives to maintain a superior video definition level to NTSC standards throughout to compensate for any loss of original image integrity incurred through the film grain-instilling process of apparatus 13 (FIG. 1), a configuration of this system for the purpose of deriving an NTSC signal from NTSC video originated material is possible with a corresponding compromise to the image derived from the resulting video signal. Referring to FIG. 1, camera 1 might be replaced by a well balanced NTSC unit with its signal being recorded on a broadcast NTSC deck, 2. NTSC deck 4, would relay a frame of video to analog-digital converter 5, and this digital data would be held in store 6, which would be of a correspondingly lesser capacity than the former store which held data binary data for a high definition video frame. Computer 7 would execute a total number of pixel-component modifications per frame of approximately half that needed for the high definition configuration, and thus the time frame needed for this phase could be correspondingly reduced. The programs and look-up-tables would remain the same, as they address the modification of each pixel, and would not be changed by the fact that fewer total pixels per frame are being modified. Store 11 would need only the capacity to hold data supplied by computer 7 corresponding to the 525 line NTSC system. This frame would be converted to analog by converter 12 and the resulting signal could be output to an external scan-doubling system 36 which would provide high definition compatible projector 21 (FIG. 3), with a signal it would project as an image with an increased number of resolved lines, as compared to a signal where blanking manifests itself as a black line between two resolved lines.

Detailed Description Paragraph Right (13):
The film grain instilling assembly 13 would remain the same, with the camera unit 22 (FIG. 3), being replaced by an NTSC unit, such as those use in present telecine "film-to-tape" systems. The option of filtering and peaking controls 16 and external color correction 17 would remain, and the NTSC signal could be routed directly from the camera unit 22 or from said optional modifier(s) for final record by a master

record deck replaced in this configuration by an, NTSC broadcast format unit 19. Final display for system previewing and reviewing would occur on monitor 20, replaced by an NTSC unit such as higher performance NTSC units used in conjunction with telecine film-to-tape transferring systems. All other system functions and data signals would remain as in the high definition configuration.

CLAIMS:

1. A video signal modification system for simulating video images originated on motion picture film stocks from high definition video originated images, including:

computing means for reassigning color and black component values for each pixel, scan-sequentially, within each frame of a high definition originated image stored on tape, based on digital component modifications;

look up table programs on which said digital component modifications are based, representing and compiled from comparative digital results of film stocks' responses to selected color chart gradients under selected lighting conditions, following a telecine transfer to digital video, as plotted against a video originated response to color and grey scale charts under same lighting combinations;

means for physically instilling selected film grain patterns of optional density and size, to the images resulting from a high definition videoprojection of frame store data derived from primary digital modification effected with said computing means;

means for videographing said videoprojection with a high definition camera unit, aligned to and with technical means to maintain a high degree of the projected image's integrity;

means for compatibly: recording; playing back; frame-storing in digital form; digitally altering; frame-storing again; reconverting to analog and videoprojecting; re-recording and displaying on a monitor, a high definition video signal; and

means for governing all insert time-code editing, system function, timing, and component advance signals through a system computer from a keyboard coupled to said system computer.

2. The system as in claim 1, said computing means including a computer having means to address and replace digital color and black component data for every pixel within a high definition image stored on tape, and to recall look-up table programs to employ as the basis of digital translations effected by said computing means.

3. The system as in claim 2, wherein said look up table programs used as the basis of the primary digital modification are of the one dimensional kind, compiled and recalled according to selected data plateaus based on the chosen film stock to be simulated and three principal videography variables:

color temperature in degrees kelvin

brightness in foot candles

the selected shooting f-stop setting.

4. The system as in claim 3, wherein look up table data for ranges of original video data, and corresponding response data indicating anticipated film stock response, are derived from detailed digital logs from analyses of videography and telecined film shot of selected color chart and grey scale gradients under the said lighting and f-stop variable combinations shared by the look-up-table being assembled.

5. The system as in claim 4, wherein the number of shooting-variable based look-up-tables prepared for a given film stock program alone determine the number of said lighting and f-stop variables available for use during principal videography.

6. The system as in claim 4, wherein said look-up-tables are at least detailed enough to contain data plateaus necessary to address those color component and grey

scale gradients deemed registrable by NTSC television standards, with any additional detail and specificity in digital component modification for providing additional color detail discernible by more sensitive television systems and monitors being determined by the incremental size of data groupings of original video data and thus the number of corresponding digital answers provided by a look-up-table employed.

8. The system as in claim 7, wherein said high definition camera model and corresponding record deck for recording the original high definition signal are designated as components of this system and are the preferred models for use in all original videography for modification by this system.

9. The system as in claim 1, wherein an apparatus provides means for instilling various grain textures to the image resulting from the primary digital modification including:

means to videoproject a high definition image on a surface 16 mm, or 35 mm wide;

a transparent grey celluloid length, or celluloid sheath, on which to manifest the projected image;

an assembly to contain the length of celluloid, with means to move the sheath intermittently, and to raise and lower it relative to a projector beam;

a camera unit, with means to generate a video synching signal for the projector unit, aligned and with high definition capability to scan synchronously with scan lines manifested on the celluloid sheath by the projector, including means to focus and frame on a 16 mm or 35 mm image as projected from the opposite side of the celluloid sheath surface;

means for applying peaking and filtering controls, familiar in film to tape transferring systems, to the camera unit and signal output by the camera unit;

means for outputting the camera signal for optional modification by an external unit, such as a separate color modification device or NTSC converter, prior to recording.

15. The apparatus as in claim 9, wherein said celluloid sheath is a length of exposed and processed motion picture film, at least one meter long and 175 mm in width, containing at least five exposed strips 35 mm in width, of increasing grain density and thus darkness, representing plural grey scale gradients.

25. The system as in claim 1, wherein all system functions, timing features, single-frame insert editing functions, advance signals and variable selections are governed by the system computer, with all system options and manual aesthetic adjustments of the digital component modification and film-grain instilling process controllable from the keyboard portion of said computer.

26. The system as in claim 1, wherein a second possible configuration of system components replaces high definition units with NTSC compatible components with the system of this configuration recording a modified NTSC signal derived from original NTSC taped material, with the video projector unit remaining the single system component with scanning line capacity of at least double that of NTSC standards.

28. The system as in claim 1, including system configuration control means for maintaining said video originated images as a digital signal, throughout, said system configuration control means including:

a digital video camera and videotape recorder for effecting principal videography;

a digital video projector and camera comprising said film grain pattern instilling means;

whereby analog-to-digital conversion prior to processing said video originated images in said look-up table means, and digital-to-analog conversion prior to effecting videoprojection of said intermediate video images, is rendered

unnecessary.

29. A video signal modification system for converting video originated images into final video images simulating images originated from motion picture film, the modification system including:

look-up table means for holding conversion data correlating color and black component values of picture pixels in said video originated images with modified component values, said conversion data being selectable for said picture pixels based on a plurality of parameters including lighting conditions;

computing means coupled to said look-up table means for reassigning values for said color and black component values for substantively each said picture pixel within each frame of said video originated images in dependence on said modified component values selected from said look-up table means and thereby producing intermediate video images;

grain pattern instilling means for physically instilling selected film grain patterns of optional density and size into said intermediate video images; and

final image producing means for producing said final video images from said intermediate video images which have had said film grain patterns instilled therein.

36. A video signal modification system for converting video originated images into final video images simulating images originated from motion picture film, the modification system including:

look-up table means for holding conversion data correlating to color and black component values of picture pixels in said video originated images with modified component values, said conversion data being selectable for said picture pixels based on a plurality of parameters including lighting conditions;

said conversion data being compiled and recallable according to a chosen film stock to be simulated, said parameters including:

(a) color temperature;

(b) brightness; and

(c) a selected shooting f-stop setting;

computing means coupled to said look-up table means for reassigning values for said color and black component values for substantively each said picture pixel within each frame of said video originated images in dependence on said modified component values selected from said look-up table means and thereby producing intermediate video images; and

means for producing said final video images from said intermediate video images.

37. The system as claimed in claim 36, wherein look-up table data for ranges of original video data, and corresponding response data indicating anticipated film stock response, are derived from detailed digital logs taken from analyses of videography and telecined film shots of selected color chart and grey scale gradients under combinations of said brightness and f-stop setting.

38. The system as in claim 37, wherein the look-up table means comprises a plurality of shooting-variable look-up tables and the number of shooting-variable look-up tables prepared for a given film stock program alone determine the number of said brightness, temperature, and f-stop settings available for use during principal videography.

node formats a data packet corresponding to the read request and arbitrates for control of the bus (assuming asynchronous packet transmission). When the arbitration is won, the source node transmits the packet over the bus. At the destination node, the read request is received and an acknowledge is returned. The destination node completes the requested read operation (under the control of its associated driver), arbitrates for the bus, and begins communicating a response. The response includes the requested data as well as a destination address. Of course, the destination address of the read response corresponds to the address of the original source node.

Detailed Description Paragraph Right (16):
If a bus reset occurs while the bus transaction is pending, the device data records are updated to reflect the new node base addresses. Once the device data records have been updated, the present invention allows previously pending bus transactions to be completed without the original source node driver having to reinitiate the transaction.

Detailed Description Paragraph Right (23):
According to the present invention, the read transaction is recognized by a software entity residing within memory associated with computer system 5. The software entity, hereinafter referred to as a service routine, comprises computer readable instructions which when executed by a processor (e.g., CPU 10), cause the processor to use the reference ID of the read transaction to obtain a pointer into the device data record. The pointer points to the correct device data record. No searching is required. According to the service routine's instructions, the device data records will be maintained with the up-to-date base addresses.

Detailed Description Paragraph Right (26):
Once the CPU node 12 output registers have been cleared, the CPU 10 must initiate the bus scan so that all device data records can be updated. To accomplish this task, the service routine must create a priority execution queue. The reason a priority execution queue is required is to ensure that the device data records are updated before the original read transaction is allowed to execute. Recall that the original read request will still be pending in the normal execution queue. If the read transaction were serviced before the device data records are updated, the read may be directed to the wrong address. Thus, the normal execution queue must be disabled until all device data records are updated. The priority execution queue, however, is not disabled.

Detailed Description Paragraph Right (28):
Once all the device data records have been updated, the original read request can be serviced. The destination address for the read request will be obtained using the updated device data records. As described above, the service routine maintained a record of the node reference ID for the intended destination node prior to the bus reset. This record, which did not change as a result of the bus reset, is now used as a pointer to the updated device data records and the new destination node base address is obtained. This new base address is appended to the read request and the transaction is allowed to complete.